

WHAT IS CLAIMED IS:

1. A device comprising:

an optical circulator having first, second, and third ports, said first port being supplied with signal light including first and second polarization components respectively having first and second polarization planes orthogonal to each other, and with pump light;

a polarization beam splitter having fourth, fifth, and sixth ports, said fourth port being optically connected to said second port, said fourth and fifth ports being coupled by said first polarization plane, said fourth and sixth ports being coupled by said second polarization plane; and

— this does not occur in fig 10 of 853 (3)

a polarization maintaining fiber having first and second ends, and having a polarization mode to be maintained between said first and second ends, said first end being optically connected to said fifth port so that said first polarization plane is adapted to said polarization mode, said second end being optically connected to said sixth port so that said second polarization plane is adapted to said polarization mode.

2. A device according to claim 1, wherein said polarization maintaining fiber has a substantially constant zero-dispersion wavelength in relation to said polarization mode, and said pump light has a wavelength

substantially equal to said zero-dispersion wavelength.

3. A device according to claim 1, wherein said signal light is converted into converted signal light by four-wave mixing based on said signal light and said pump light in said polarization maintaining fiber, said converted signal light being output from said third port of said optical circulator.

4. A device according to claim 3, wherein said converted signal light is a phase conjugate of said signal light.

5. A device according to claim 3, wherein:

said pump light has a third polarization plane;

said third polarization plane being set so that the efficiency of conversion from said signal light to said converted signal light is independent of the polarization state of said signal light.

6. A device according to claim 3, wherein said signal light, said pump light, and said converted signal light have angular frequencies ω_s , ω_p , and ω_c , respectively, said angular frequencies ω_s , ω_p , and ω_c substantially satisfying the relation of $2\omega_p = \omega_s + \omega_c$.

7. A device according to claim 3, further comprising an optical band-pass filter optically connected to said third port of said optical circulator and having a passband including the wavelength of said converted

signal light.

8. A device according to claim 1, wherein said polarization maintaining fiber has first and second principle axes orthogonal to each other, and said polarization mode corresponds to one of said first and second principal axes.

9. A device according to claim 1, further comprising:
a pumping source for outputting said pump light;
and

an optical coupler optically connected to said first port of said optical circulator for combining said signal light and said pump light.

10. A device according to claim 1, further comprising means for modulating or dithering the frequency or phase of said pump light.

11. A device comprising:
a polarization beam splitter having first, second, and third ports, said first port being supplied with signal light including first and second polarization components respectively having first and second polarization planes orthogonal to each other, and with pump light, said first and second ports being coupled by said first polarization plane, said first and third ports being coupled by said second polarization plane; and
a polarization maintaining fiber having first and

second ends, and having a polarization mode to be maintained between said first and second ends, said first end being optically connected to said second port so that said first polarization plane is adapted to said polarization mode, said second end being optically connected to said third port so that said second polarization plane is adapted to said polarization mode.

12. A device according to claim 11, further comprising an optical circulator optically connected to said first port of said polarization beam splitter.

13. A device according to claim 11, wherein said polarization maintaining fiber has a substantially constant zero-dispersion wavelength in relation to said polarization mode, and said pump light has a wavelength substantially equal to said zero-dispersion wavelength.

14. A system comprising:

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a' / first and second optical fiber networks each adapted to wavelength division multiplexing; and

a converter connected between said first and second optical fiber networks, said converter converting signal light into converted signal light by nonlinear optical effect based on said signal light and pump light.

15. A system according to claim 14, wherein said signal light is converted into said converted signal light by a second-order or third order nonlinear optical

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effect.

16. A system according to claim 14, wherein said signal light is converted into said converted signal light by four-wave mixing based on said signal light and said pump light.

17. A system according to claim 14, wherein said converted signal light is a phase conjugate of said signal light.

18. A system according to claim 14, wherein said signal light is WDM signal light obtained by wavelength division multiplexing a plurality of optical signals having different wavelengths.

19. A system according to claim 18, wherein the wavelengths of said plurality of optical signals are arranged at unequal intervals.

20. A system according to claim 14, wherein said converter comprises:

a pumping source for outputting pump light;

an optical circulator having first, second, and third ports, said first port being supplied with signal light including first and second polarization components respectively having first and second polarization planes orthogonal to each other, and with said pump light;

a polarization beam splitter having fourth, fifth, and sixth ports, said fourth port being optically

connected to said second port, said fourth and fifth ports being coupled by said first polarization plane, said fourth and sixth ports being coupled by said second polarization plane; and

a polarization maintaining fiber having first and second ends, and having a polarization mode to be maintained between said first and second ends, said first end being optically connected to said fifth port so that said first polarization plane is adapted to said polarization mode, said second end being optically connected to said sixth port so that said second polarization plane is adapted to said polarization mode.

20 21. A system according to claim 14, wherein:

said first optical fiber network includes a first fiber span for transmitting said signal light; and

said second optical fiber network includes a second fiber span for transmitting said converted signal light.

21 22. A system according to claim ²⁰21, wherein when each of said first and second fiber spans is virtually divided into the same number of sections, the product of the average of chromatic dispersions of a first one of said sections of said first fiber span and the length of said first one is substantially equal to the product of the average of chromatic dispersions of a second one of said sections of said second fiber span and the length of said

second one, said first and second ones corresponding to each other in order as counted from said converter, and the product of the average of optical powers in said first one, the average of nonlinear coefficients in said first one, and the length of said first one is substantially equal to the product of the average of optical powers in said second one, the average of nonlinear coefficients in said second one, and the length of said second one.

22 ~~23~~ ²⁰ A system according to claim ~~21~~, wherein:

the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a first point on said first fiber span is substantially equal to the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a second point on said second fiber span;

an accumulated value of chromatic dispersions measured from said converter to said first point being equal to an accumulated value of chromatic dispersions measured from said converter to said second point.

23 ~~24~~ ²⁰ A system according to claim ~~21~~, wherein:

the ratio of the product of an optical power and a nonlinear coefficient to a chromatic dispersion at a first point on said first fiber span is substantially equal to the ratio of the product of an optical power and

a nonlinear coefficient to a chromatic dispersion at a second point on said second fiber span;

an accumulated value of the products of optical powers and nonlinear coefficients measured from said converter to said first point being equal to an accumulated value of the products of optical powers and nonlinear coefficients measured from said converter to said second point.

24 25. A system according to claim 21, wherein the product of the average of chromatic dispersions of said first fiber span and the length of said first fiber span is substantially equal to the product of the average of chromatic dispersions of said second fiber span and the length of said second fiber span. 20

25 26. A system according to claim 21, wherein the product of the average of optical powers in said first fiber span, the average of nonlinear coefficients in said first fiber span, and the length of said first fiber span is substantially equal to the product of the average of optical powers in said second fiber span, the average of nonlinear coefficients in said second fiber span, and the length of said second fiber span. 20

27. A device comprising:

a first optical circulator having first, second, and third ports, said first port being supplied with

first signal light including first and second polarization components respectively having first and second polarization planes orthogonal to each other, and with first pump light;

a second optical circulator having fourth, fifth, and sixth ports, said fourth port being supplied with second signal light including third and fourth polarization components respectively having third and fourth polarization planes orthogonal to each other, and with second pump light;

a polarization beam splitter having seventh, eighth, ninth, and tenth ports, said seventh port being optically connected to said second port, said tenth port being optically connected to said fifth port, said seventh and eighth ports being coupled by said first polarization plane, said seventh and ninth ports being coupled by said second polarization plane, said ninth and tenth ports being coupled by said third polarization plane, said eighth and tenth ports being coupled by said fourth polarization plane; and

a polarization maintaining fiber having first and second ends, and having first and second polarization modes to be maintained between said first and second ends, said first end being optically connected to said seventh port so that said first and fourth polarization planes

are respectively adapted to said first and second polarization modes, said second end being optically connected to said eighth port so that said second and third polarization planes are respectively adapted to said first and second polarization modes.

28. A device according to claim 27, wherein said polarization maintaining fiber has a substantially constant zero-dispersion wavelength in relation to each of said first and second polarization modes, and each of said first and second pump lights has a wavelength substantially equal to said zero-dispersion wavelength.

29. A device according to claim 27, wherein:

said first signal light is converted into first converted signal light by four-wave mixing based on said first signal light and said first pump light in said polarization maintaining fiber, said first converted signal light being output from said third port of said first optical circulator; and

said second signal light is converted into second converted signal light by four-wave mixing based on said second signal light and said second pump light in said polarization maintaining fiber, said second converted signal light being output from said sixth port of said second optical circulator.

30. A device according to claim 29, wherein said first

and second converted signal lights are phase conjugates of said first and second signal lights, respectively.

31. A system comprising:

first and second optical fiber networks each adapted to wavelength division multiplexing; and

a converter connected between said first and second optical fiber networks;

said converter comprising:

first and second pumping sources for outputting first and second pump lights, respectively;

a first optical circulator having first, second, and third ports, said first port being supplied with first signal light including first and second polarization components respectively having first and second polarization planes orthogonal to each other, and with said first pump light;

a second optical circulator having fourth, fifth, and sixth ports, said fourth port being supplied with second signal light including third and fourth polarization components respectively having third and fourth polarization planes orthogonal to each other, and with said second pump light;

a polarization beam splitter having seventh, eighth, ninth, and tenth ports, said seventh port being optically connected to said second port, said tenth port being

optically connected to said fifth port, said seventh and eighth ports being coupled by said first polarization plane, said seventh and ninth ports being coupled by said second polarization plane, said ninth and tenth ports being coupled by said third polarization plane, said eighth and tenth ports being coupled by said fourth polarization plane; and

a polarization maintaining fiber having first and second ends, and having first and second polarization modes to be maintained between said first and second ends, said first end being optically connected to said seventh port so that said first and fourth polarization planes are respectively adapted to said first and second polarization modes, said second end being optically connected to said eighth port so that said second and third polarization planes are respectively adapted to said first and second polarization modes.

32. A system according to claim 31, wherein:

said first signal light is converted into first converted signal light by four-wave mixing based on said first signal light and said first pump light in said polarization maintaining fiber, said first converted signal light being output from said third port of said first optical circulator; and

said second signal light is converted into second

converted signal light by four-wave mixing based on said second signal light and said second pump light in said polarization maintaining fiber, said second converted signal light being output from said sixth port of said second optical circulator.

33. A system according to claim 31, wherein said first and second converted signal lights are phase conjugates of said first and second signal lights, respectively.

34. A device comprising:

a polarization beam splitter having first, second, and third ports, said first and second ports being coupled by a first polarization plane, said first and third ports being coupled by a second polarization plane orthogonal to said first polarization plane; and

a polarization maintaining fiber having first and second ends, and having a polarization mode to be maintained between said first and second ends, said polarization maintaining fiber being supplied with signal light including first and second polarization components respectively having said first and second polarization planes, and with pump light; said signal light being converted into converted signal light by nonlinear optical effect based on said signal light and pump light in said polarization maintaining fiber.